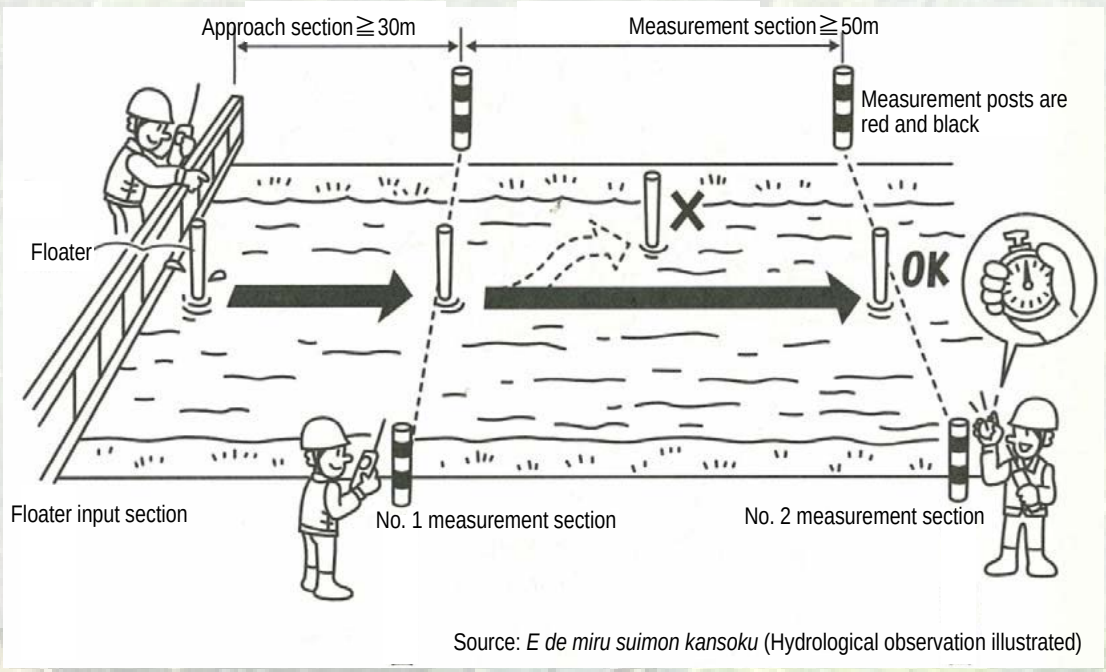
Image Analysis-Based Flow Observation Software, Part 1

Background

Data about flow rates obtained from flow observation is critical, forming the core of river management and road planning. Since around 1955, high-water (flood) flow observations in Japan have been performed using the floater method, which involves the use of rod-shaped floaters (rod floaters). However, as flooding has intensified over the past several years, surveyors have been unable to take measurements because they cannot safely access rivers in an increasing number of cases. Securing personnel is also an issue due to avoidance of long hours and the decreasing birth rate and aging population in rural areas.



Source: *E de miru suimon kansoku* (Hydrological observation illustrated)

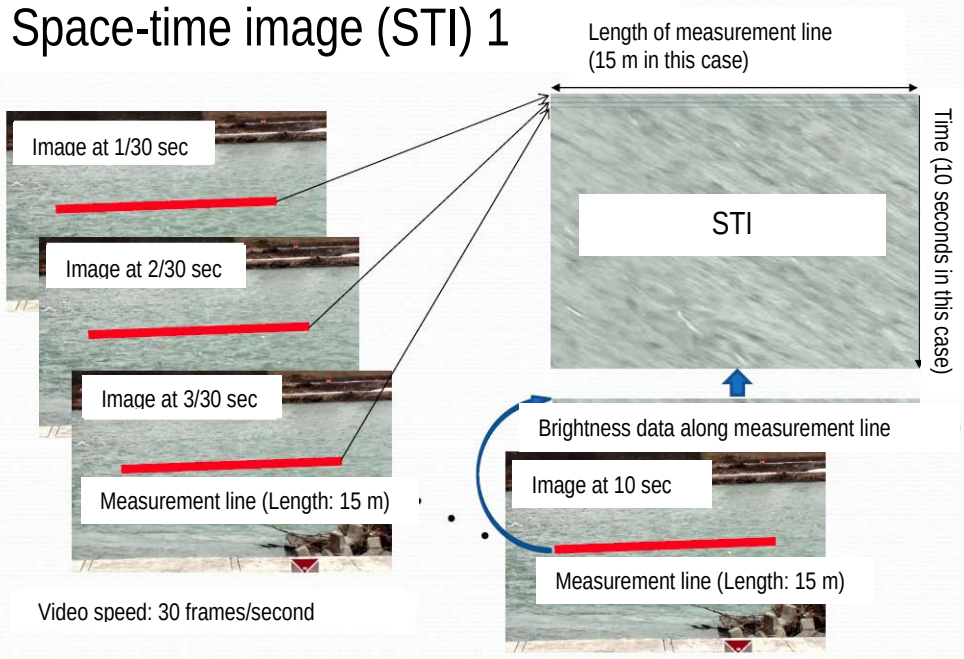
There are many issues with the floater method

- Difficulty securing personnel
- Difficulty setting up by the time flooding peaks
- Accuracy of observations depends on personnel
- Working during storms is dangerous
- Floaters cannot flow downstream smoothly because of trees, wake from bridge piers, etc.

A new method of observation is needed to replace the floater method

Image analysis: Space-time image velocimetry (STIV)
A method of measuring river surface flow velocity based on video images, developed by Kobe University Professor Emeritus Ichiro Fujita

Space-time image (STI) 1



Space-time image (STI) 2

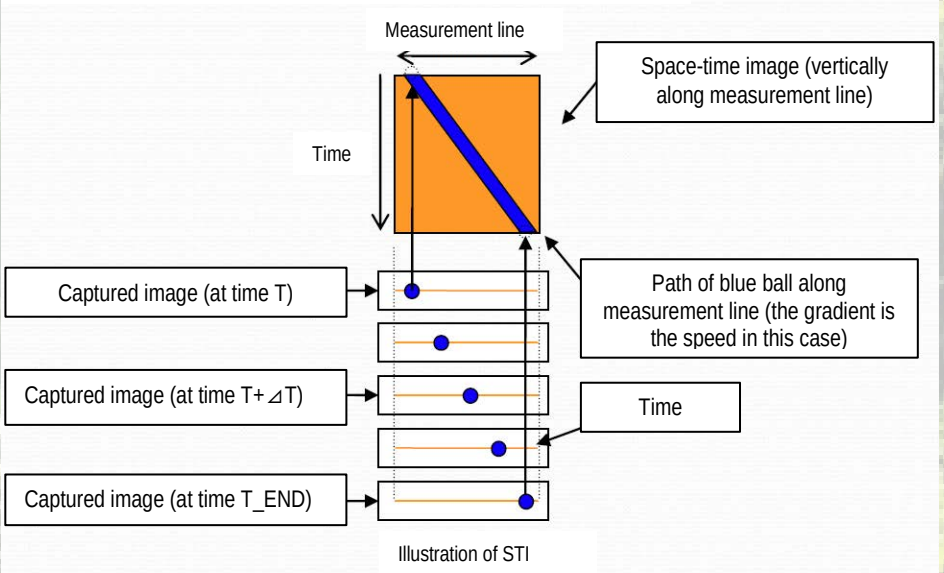


Illustration of STI

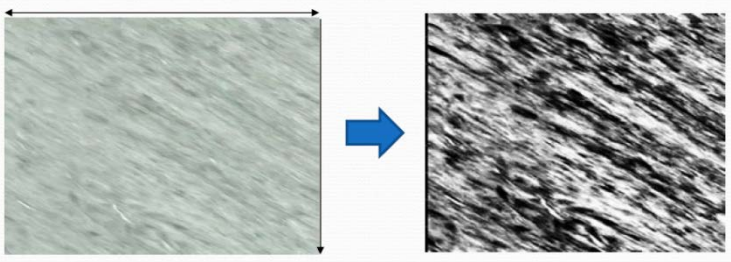
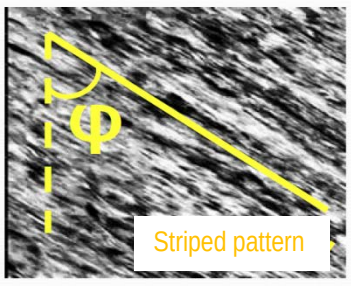


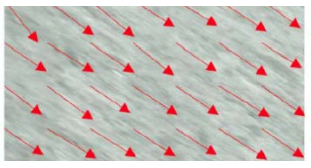
Image filter used to emphasize the striped pattern



The striped pattern of STI represents the buildup of debris, foam, ripples, and the like over time along the measurement line

Flow velocity V is determined by finding the gradient of the striped pattern (tanφ)

Gradient of the striped pattern determined using the brightness gradient tensor method



Divide the STI by the specific area size to determine the angle from the brightness gradient

Heavy weighting when the pattern is clear, light weighting when the pattern is blurry

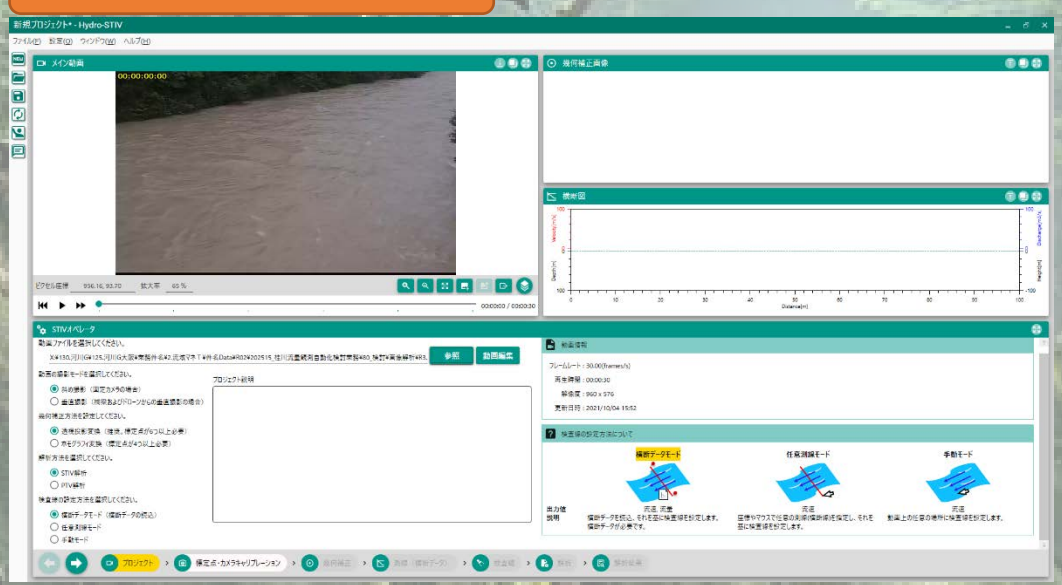
Videos of river surfaces captured with a video camera are displayed on a computer screen, and measurement lines are drawn on the river surface. The measurement lines are roughly 1 pixel thick, and the length in this case is the actual scale: 15 m (actual length depends on the filming conditions). The video is played with the lines drawn, and brightness data along the measurement lines are extracted and lined up for each frame as the video is played. The two-dimensional image resulting from the alignment of this brightness data is known as the space-time image (STI), and it has a horizontal axis the same length as the measurement lines (15 m) with time on the vertical axis. The shooting speed of videos in Japan is 30 frames per second, so if a video is 10 seconds long, there will be 300 measurement lines (300 pixels) lined up vertically. Ripples, debris, or the like observed flowing along the measurement lines in videos appear as diagonal stripes in STI. The slopes of these diagonal stripe patterns represent the flow velocity (Length (distance) ÷ Time); therefore, in STIV, lines are set automatically, and their slopes are determined and used to calculate flow velocity.

Image Analysis-Based Flow Observation Software, Part 2

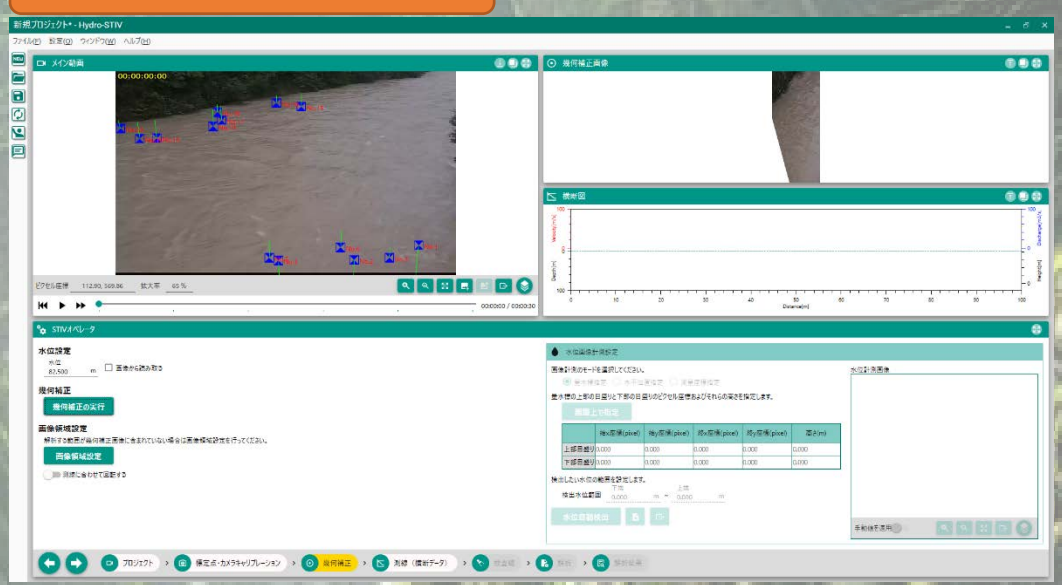
Software for simple, high-precision calculations of flow velocity and flow rate from images and water level data

Screenshot of the system in operation

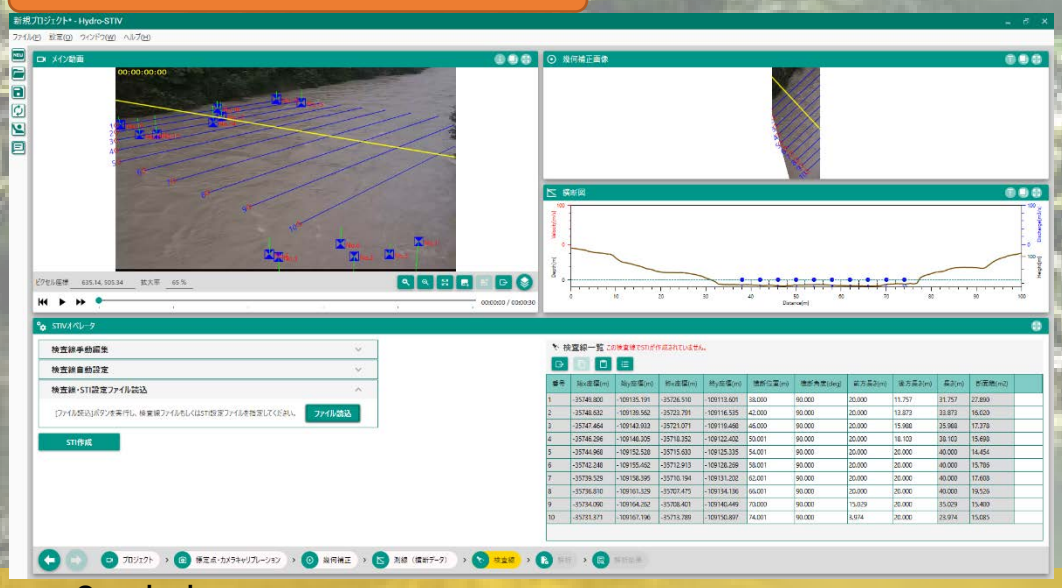
Screenshot: Loading



Screenshot: Geometric conversion



Screenshot: Cross-section/measurement line setting



Screenshot: Flow velocity/flow rate calculation

Conclusion

- Equipment costs less than other methods (monitoring cameras can be used instead of video cameras)
- Using stationary cameras in the field is safer during floods because personnel do not need to work in the field
- Accuracy of observation is at least as good as the floater method
- Continuous observation is possible
- Images are saved, making it possible to verify the causes of abnormal values at a later time
- Easy to operate (operations are intuitive)

*The software (Hydro-STIV) is sold by Hydro Technology Institute Co., Ltd.